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<p>(21) International Application Number: PCT/US89/03028 (22) International Filing Date: 13 July 1989 (13.07.89) (30) Priority data: 218,779 13 July 1988 (13.07.88) US (71) Applicant: W. L. GORE &amp; ASSOCIATES, INC. [US/US]; 551 Paper Mill Road, P.O. Box 9206, Newark, DE 19714 (US). (72) Inventors: SASSA, Robert, Louis ; One Francis Circle, Newark, DE 19711 (US). BAILEY, Christian, Edward ; 700 Principio Road, Port Deposit, MD 21904 (US). (74) Agents: SAMUELS, Gary, A. et al.; W. L. Gore &amp; Associates, Inc., 551 Paper Mill Road, P.O. Box 9206, Newark, DE 19714 (US).</p>		<p>(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent).  Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
<p>(54) Title: EXPANDED POLYTETRAFLUOROETHYLENE TUBULAR CONTAINER</p> <div data-bbox="777 1739 1638 2102" data-label="Image"> </div> <p>(57) Abstract</p> <p>A container for adsorbing components present in an environment, which comprises a tubular structure of expanded, porous polytetrafluoroethylene sealed at both ends, so as to encapsulate an adsorbent present with the tubular structure.</p>		

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## EXPANDED POLYTETRAFLUOROETHYLENE TUBULAR CONTAINER

FIELD OF THE INVENTION

This invention relates to a novel tubular container having an adsorbent material inside, and more specifically, to a novel container having very small pores in its walls that allow it to be permeable to gases, selected liquids and solutes, but impermeable to other larger size materials and other selected liquids.

BACKGROUND OF THE INVENTION

Containers that contain adsorbents to remove vaporous impurities in the atmosphere are well known. For example, they can be used to remove water vapor from air to obtain or maintain a dry atmosphere in applications where a moisture-free atmosphere is important, as for example in keeping hygroscopic materials dry. Another example is the removal of organic vapors from air to avoid contamination of local environments sensitive to such vapors, as for example in preventing head (stiction) failures in computer disk drives.

It is well known that greater effectiveness in removing of material from the atmosphere by adsorption can be obtained if the surface area of the adsorbent is maximized. Thus the smaller the adsorbent materials in particle size, the greater the effectiveness in removing impurities. Unfortunately, the smaller the particle size, the greater amount of dust-like fines that can be present. Moreover, even coarse adsorbent materials generate fines by mutual abrasion of the coarse granules.

To protect the adsorbent particles, a protective porous material i.e., a material that permits passage through it of gaseous components or other components is usually employed to surround and encase the adsorbent. But if the pores of the protective material are too large, the fines of the adsorbant material will escape through the pores and contaminate the outside environment. To prevent such escape, it is desirable for the protective covering to have pores small enough to prevent escape of very small diameter fines, i.e., fines on the order of 10 microns, or even 1 micron or less in size.

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SUMMARY OF THE INVENTION

This invention provides an adsorbent-containing device having such a protective covering. The device comprises a container for selectively adsorbing gaseous components present in an environment, which container comprises a tubular structure of expanded, porous polytetrafluoroethylene, said tubular structure being sealed at both ends, so as to encapsulate an adsorbent present within the tubular structure, the pores of said porous polytetrafluoroethylene having an average size of between about 0.1 and 1 micron, with substantially no pores greater than 5 micron in size.

DESCRIPTION OF THE DRAWINGS

Figure 1 depicts an embodiment of the tubular container of the present invention, cut away to expose the interior of the tubular container with adsorbent particles inside.

Figure 2 is a view of the tubular container cut along line 2-2 of Figure 1, but without having any adsorbent particles inside.

DESCRIPTION OF THE INVENTION

Referring to the Figures, the tubular container of the invention comprises a tube 10 made of expanded porous polytetrafluoroethylene sealed at each end 11 so as to enclose adsorbent particles 12.

The tube can be slightly to very flexible, depending on the strength of the polytetrafluoroethylene and the thickness of the walls. For most applications, the wall thickness will be between 10 and 50 mils (250-1250 micron) on average. The expanded porous polytetrafluoroethylene tube is made according to the procedures described in U.S. Patents 4,110,392, 4,187,390, 4,075,679 and 3,953,566. More specifically, coagulated dispersion polytetrafluoroethylene (PTFE) is lightly lubricated and extruded as a paste through an annular-die extruder. In a series of

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heating and stretching steps the lubricant is evaporated away and the PTFE structure is expanded such that the percent void space or porosity is finally about 30-80%. The resulting tube is sintered by heating above the crystalline melt temperature of PTFE. Under one set of conditions such a tube is made having an inside diameter of 0.079 inches, a wall thickness of 0.016 inches, pores of maximum size 2.0  $\mu\text{m}$ , 50% porosity, and air permeability through the wall of 0.005 cm/sec at 1.27 cm  $\text{H}_2\text{O}$  P. Under different conditions a tube is made of inside diameter 0.50 inches, a wall thickness of 0.039", a maximum pore size of 3.5  $\mu\text{m}$  and a porosity of 70%.

In operation, once the tube is prepared, it is sealed at one end by any suitable sealing means. For example, heat sealing can be carried out by using an adhesive such as polyethylene, or a melt-processible tetrafluoroethylene copolymer, and heating and compressing the end of the tube to result in the configuration shown in the drawings or simply fusion bonding the tube to itself. An alternate method is to seal one end by means of a plug that is snugly fitted in the end.

The tube is then filled with an adsorbent particulate, such as silica gel, activated carbon, calcium sulfate, calcium carbonate, activated alumina, molecular sieves or the like. The remaining open end is then sealed in a manner like the other end.

In practice, an adsorbent-filled tubular container made of expanded porous polytetrafluoroethylene, about two inches long, 0.6 inch diameter and 0.5 inch inside diameter filled with 5 grams anhydrous  $\text{CaSO}_4$  (Calcium Sulfate) was used to adsorb water vapor from the interior of a 9 liter sealed glass jar. The relative humidity inside the jar was reduced to 20% RH from an initial 60% RH with the addition of the adsorbent tube.

Pore size is measured by microscopy.

Porosity (% void space) is measured by density (weight per volume) measurements.

Claims

1. A container for selectively adsorbing components present in an environment, which comprises a tubular structure of expanded, porous polytetrafluoroethylene, said tubular structure being sealed at both ends so as to encapsulate an adsorbent present within the tubular structure, the pores of said polytetrafluoroethylene having an average size of between about 0.1 and 1 micron, with substantially no pores greater than 5 micron in size.
2. The container of claim 1 wherein the average wall thickness is between 10 and 50 mils.
3. The container of claim 2 wherein the length of the container is between 0.25 and 20 inches.
4. The container of claim 1 wherein the adsorbent is calcium sulfate.
5. The container of claim 1 wherein the adsorbent is activated carbon.
6. The container of claim 1 wherein the adsorbent is silica gel.
7. The container of claim 1 wherein the adsorbent is calcium carbonate.
8. The container of claim 1 wherein the adsorbent is activated alumina.
9. The container of claim 1 wherein the adsorbent is molecular sieves.
10. The container of claim 1 wherein the ends of the tube are sealed with an adhesive.
11. The container of claim 1 wherein the adsorbent is sealed by fusion of PTFE to PTFE.

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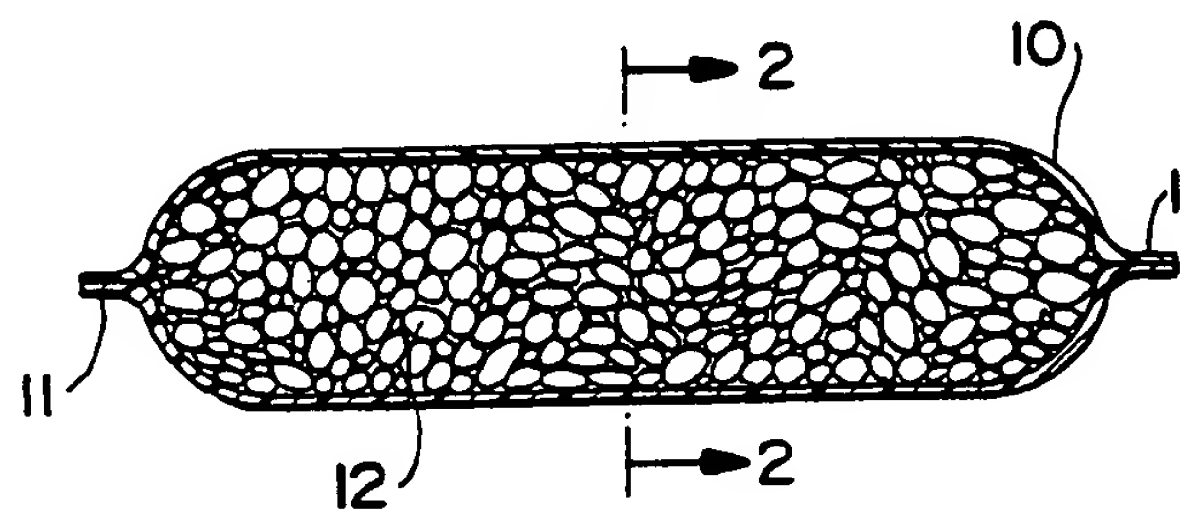


Fig. 1

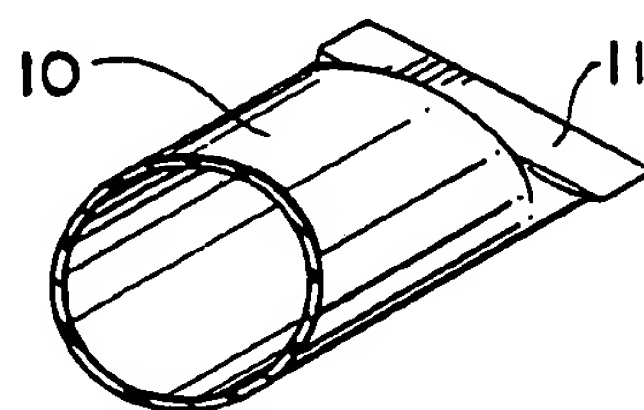


Fig. 2

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US 89/03028

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC <sup>5</sup> : B 01 D 53/26, B 01 D 53/04, B 65 D 81/26		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
IPC <sup>5</sup>	B 01 D, B 65 D	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b>		
Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	US, A, 4110392 (E. YAMAZAKI) 29 August 1978, see abstract  cited in the application --	1-11
Y	GB, A, 2126123 (J. CORNFORTH) 21 March 1984, see page 1, lines 95-107 --	1-11
A	US, A, 3990872 (J. CULLEN) 9 November 1976, see claims --	
A	EP, A, 0154620 (U. SLEYTR) 11 September 1985, see claims 1,31,32 --	
A	US, A, 4383376 (Y. NUMAMOTO) 17 May 1983, see column 4, lines 44-55 --	
A	FR, A, 2448488 (MITSUBISHI) 5 September 1980, see claims -----	
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p>* Special categories of cited documents: <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"Δ" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
12th September 1989	16. 11. 89	
International Searching Authority	Signature of Authorized Officer	
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**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

US 8903028  
SA 29975

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 08/11/89. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4110392	29-08-78	None	
GB-A- 2126123	21-03-84	None	
US-A- 3990872	09-11-76	None	
EP-A- 0154620	11-09-85	AT-A- 381463	27-10-86
		WO-A- 8504111	26-09-85
		JP-T- 61501619	07-08-86
		US-A- 4849109	18-07-89
		US-A- 4752395	21-06-88
US-A- 4383376	17-05-83	None	
FR-A- 2448488	05-09-80	DE-A- 3004325	14-08-80
		US-A- 4421235	20-12-83

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82